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(54) System for utility demand monitoring and control

(57) A system for electric power demand monitoring and control includes one or more data distribution networks interconnecting intelligent utility units located at customer homes with a host computer located in the utility company offices. Each intelligent utility unit is associated with a customer home for connecting and disconnecting a power service meter, monitoring customer demand, and controlling power to selected units. A network within the home interconnects each intelligent utility unit with power consuming units for providing data on power usage and power control. A data distribution network interconnects the plurality of intelligent utility units to the host computer as a head end unit, the data distribution network providing downstream communication channels from the host computer to the plurality of intelligent utility units and upstream communication channels from the plurality of intelligent utility units to the host computer. The communication channels are organized as frequency division multiplex channels in a frequency spectrum. A plurality of distribution networks can be provided for a larger utility environment with each distribution network associated with a power substation and customers served by the power substation.

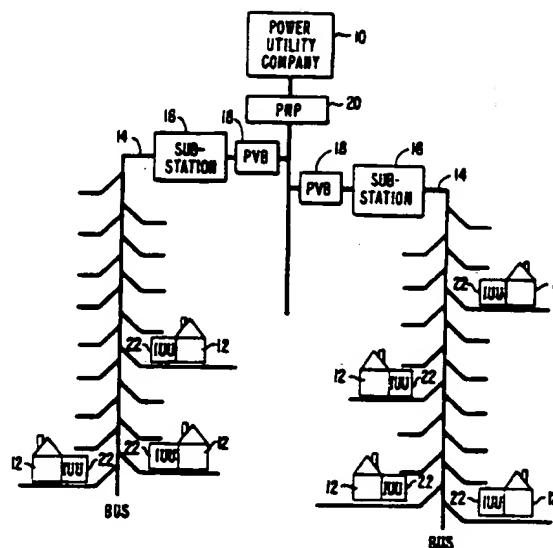


FIG. 1.

In a mid-split system, the frequencies from 5 to 108 MHz (17 channels) are used to carry signal in the inbound direction, and the frequencies from 162 MHz to 1 GHz (50+ channels) are used to carry signals in the outbound direction. See Table 2 for a representative mid-split cable spectrum.

In a high-split system, the frequencies from 5 to 175 MHz (30 channels) are used to carry signals in the inbound direction, and the frequencies from 220 MHz to 1 GHz (35+ channels) are used to carry signals in the outbound direction. See Table 3 for a representative high-split cable spectrum.

A multi-tiered addressing scheme is employed in the network. Each IUU contains the following address structure:

Physical unit address--six-byte address unique to every unit. The address is written in HEX and coded into each IUU.

Group address--allows addressing of assigned group less than all users.

Broadcast address--allows addressing of all system users.

This addressing structure allows the network manager to directly communicate with each individual IUU, a group of IUUs, and all IUUs.

The gateway between the distribution network and the digital backbone interfaced to the host computer is located in the utility company substations. A power view bridge (PVB) provides the routing function between the distribution network and the backbone network. The bridge processor keeps track of IUU addresses and the network processor address and performs the routing function for all packets between the networks. The bridge also performs a filtering function in passing data only to valid known addresses.

Fig. 6 is a functional block diagram of the digital backbone network which interfaces the host computer with the plurality of distribution networks. The backbone network includes a Frame Relay T1 interface for providing the interface between the gateway and the backbone network. A PowerView Network Processor (PNP) which provides an interface between T1 data streams and the utility host computer which provides the management of the overall network. The backbone network can be organized as a star, ring or bus. The actual topology is not important since circuits will be dedicated from the utility substations to the host computer. The digital circuits terminate at a PNP near the utility company's host computer. The backbone network can operate from T-1 rates upwards and exceeding T-3 rates, depending upon network and utility size. The T1 network distribution media is twisted wire, optical fiber, coaxial cable, or microwave. The T3 networks are either fiber or microwave. Minimum network speed is T-1. Network addressing is a function of the circuits dedicated to the distribution network and a lower level addressing between the IUUs and the utility company's host computer.

The application package within the host computer includes the ability to collect information about time of day power consumption, the ability to remotely configure the home network through the IUU, the ability to change the price tier in real time either up or down as a function of power generation and consumption, and the ability to collect and process the customer's utility bill which breaks down power consumption by device, time of day, override conditions, and the like in order to provide an itemized billing statement to the customer.

There has been described a system for utility demand monitoring and control and including a distribution network which facilitates demand side management of utility consumption. While the system has been described with reference to an illustrative electric power utility embodiment, the description is illustrative of the invention and is not to be construed as limiting the invention. The system can be used with other utilities such as gas and water as well as with telephone and cable television networks. Other functions are readily incorporated such as security systems. Thus, various modifications and applications will occur to those skilled in the art without departing from the true spirit and scope of the invention as defined by the appended claims.

TABLE 1

SUB-SPLIT BROADBAND

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		<u>Outbound</u>		
		Chnl	Band, MHz	
GUARD BAND		ZZ	450-456	
30-54 MHz		YY	444-450	
		XX	438-444	
		WW	432-438	
		VV	426-432	
		UU	420-426	
		TT	414-420	
		SS	408-414	
		RR	402-408	
		QQ	396-402	
		PP	390-396	
		OO	384-390	
		NN	378-384	
		MM	372-378	
		LL	366-372	
		KK	360-366	
		JJ	354-360	
		II	348-354	
		HH	342-348	
		GG	336-342 w/T10	
PowerView Channels	T10	23.75-29.75	FF	330-336 w/T9
	T9	17.75-23.75	EE	324-330 w/T8
	T8	11.75-17.75	DD	318-324 w/T10
	T7	5.75-11.75	CC	312-318 w/T9
		BB	306-312 w/T8	
		AA	300-306 w/T10	
		W	294-300 w/T9	
		V	288-294	
		U	282-288	
		T	276-282	
		S	270-276	
		R	264-270	
		Q	258-264	
		P	252-258	
		O	246-252	
		N	240-246	
		M	234-240	
		L	228-234	
		K	222-228	
		J	216-222	
		13	210-216	
		12	204-210	
				
		2	54-60	

Powerview
Channels

TABLE 2
BROADBAND

		Outbound	
		Chnl	Band, MHz
5		ZZ	450-456
		YY	444-450
		XX	438-444
10		WW	432-438
		VV	426-432
		UU	420-426
		TT	414-420
		SS	408-414
15		RR	402-408
		QQ	396-402
		PP	390-396
		OO	384-390
		NN	378-384
	GUARD BAND	MM	372-378
20	114-150 MHz	LL	366-372
		KK	360-366
		JJ	354-360
		II	348-354
		HH	342-348
25		GG	336-342
		FF	330-336
		EE	324-330
		DD	318-324
		CC	312-318
		BB	306-312
30		AA	300-306
	A2'	W	294-300
	FM3'	V	288-294
	FM2'	U	282-288
	FM1'	T	276-282
	6'	S	270-276
35	5'	R	264-270
	4A'	Q	258-264
	4'	P	252-258
	3'	O	246-252
	2'	N	240-246
	T14	M	234-240
40	T13	L	228-234
	T12	K	222-228
	T11	J	216-222
	T10	13	210-216
	T9	12	204-210
45	T8	11	198-204
	T7	10	192-198
		9	186-192
		8	180-186
		7	174-180
50		I	168-174
		H	162-168
		G	156-162
		F	150-156

PowerView
Channels

PowerView
Channels

TABLE 3

SPLIT BROADBAND

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		Outbound	
		Chnl	Band, MHz
		ZZ	450-456
		YY	444-450
		XX	438-444
		WW	432-438
		VV	426-432
	GUARD BAND	UU	420-426
	186-222 MHz	TT	414-420
		SS	408-414
		RR	402-408
	Inbound	QQ	396-402
	Chnl Band, MHz	PP	390-396
		OO	384-390
		NN	378-384
	8' 180-186	MM	372-378
	7' 174-180	LL	366-372
	6' 168-174	KK	360-366
	5' 162-168	JJ	354-360
	4' 156-162	II	348-354
	3' 150-156	HH	342-348
	2' 144-150	GG	336-342
	1' 138-144	FF	330-336
		EE	324-330
		DD	318-324
		CC	312-318
		BB	306-312
		AA	300-306
		W	294-300
		V	288-294
		U	282-288
		T	276-282
		S	270-276
		R	264-270
		O	258-264
		P	252-258
		O	246-252
		N	240-246
		M	234-240
		L	228-234
		K	222-228
	T14		47.75-53.75
	T13		41.75-47.75
	T12		35.75-41.75
	T11		29.75-35.75
	T10		23.75-29.75
	T9		17.75-23.75
	T8		11.75-17.75
	T7		5.75-11.75

PowerView
ChannelsPowerView
Channels

Claims

1. A system for utility demand monitoring and control comprising:

5 a host computer having access to power utility customers for receiving customer data and providing management reports on customer demand and billing statements to customers,
 a plurality of intelligent utility units, each unit associated with a customer's home for connecting and disconnecting a service meter and monitoring customer utility demand,
 a home network interconnecting each intelligent utility unit with utility units within a home for providing data on
 10 utility usage, and
 a distribution network interconnecting said plurality of intelligent utility units.

2. The system as defined by claim 1 comprising communication channels which are organised as frequency and time division multiplexed channels in a frequency spectrum.

3. The system as defined by claim 1 or 2 comprising communication channels which include voice and data channels, and video channels.

4. The system as defined by claim 1, 2, or 3, wherein said distribution network comprises a fibre distribution network, or a coaxial distribution network, or a wireless network, or a combination of a fibre distribution network, a coaxial distribution network, and a wireless network.

5. The system as defined by any preceding claim wherein said host computer includes a digital backbone network for interfacing with said distribution network, said backbone interface including a Frame Relay with said distribution
 25 network and a Frame Relay router to interface the digital backbone data stream and said host computer.

6. The system as defined by any one of claims 1 to 4 wherein said host computer includes a digital backbone network for interfacing with said distribution network, said backbone interface including an ATM interface with said distribution
 30 network and an ATM interface router to interface the digital backbone data stream and said host computer.

7. The system as defined by claim 5 or 6 including a plurality of distribution networks each running from a power substation to a plurality of customer homes, said backbone network including a multiplexer for interfacing with said plurality of distribution networks.

8. The system as defined by any preceding claim, wherein said distribution network comprises a Frequency Division Multiplexed Cable TV system, containing a data stream in a television channel space, that contains a Time Division Multiplexed Voice Time Slot system, upon which a Carrier Sense Multiple Access with Collision Detection packet switched network is placed using at least one Voice Time Slot for packet data transmission.

9. A distribution network for communicating between a host computer and a plurality of customer homes in an electric power utility demand monitoring and control system, said distribution network comprising

a plurality of intelligent units, each associated with a customer home for connecting and disconnecting a power service meter and monitoring customer power demand,

45 a data transmission line interconnecting said plurality of intelligent utility units, said data transmission line providing downstream communication channels from said host computer to said plurality of intelligent utility units and upstream communication channels from said plurality of intelligent utility units to said host computer.

10. The distribution system as defined by claim 9 wherein said communication channels are organised as frequency and time division multiplexed channels in a frequency spectrum.

11. The distribution network as defined by claim 9 or 10 wherein said transmission line comprises a coaxial cable, or a fibre cable, or a wireless cable, or a twisted pair.

12. The distribution network as defined by claim 9, 10 or 11, wherein said distribution network comprises a Frequency Division Multiplexed Cable TV system, containing a data stream in a television channel space, that contains a Time Division Multiplexed Voice Time Slot system, upon which a Carrier Sense Multiple Access with Collision Detection packet switched network is placed using at least one Voice Time Slot for packet data transmission.

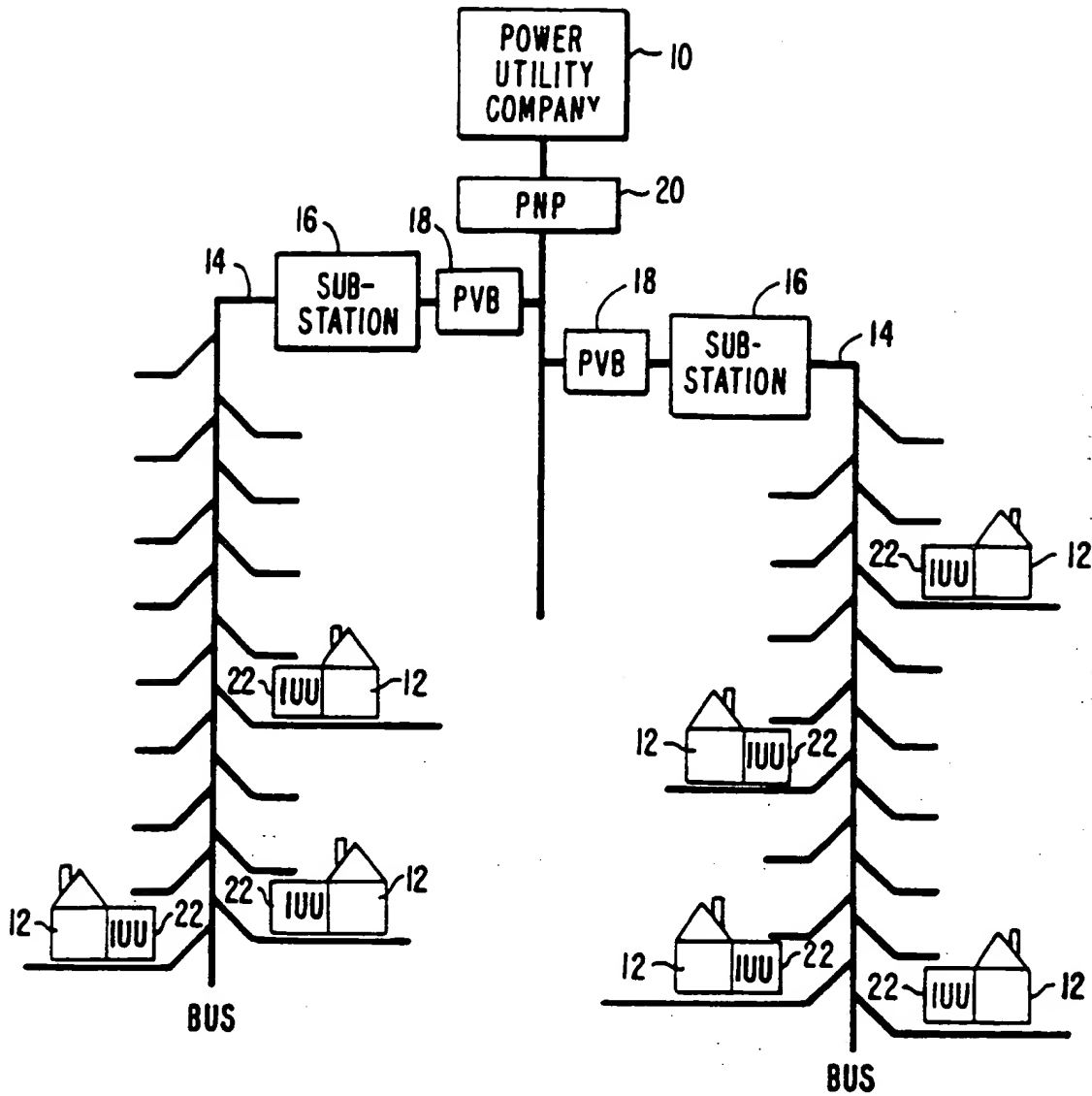


FIG. 1.

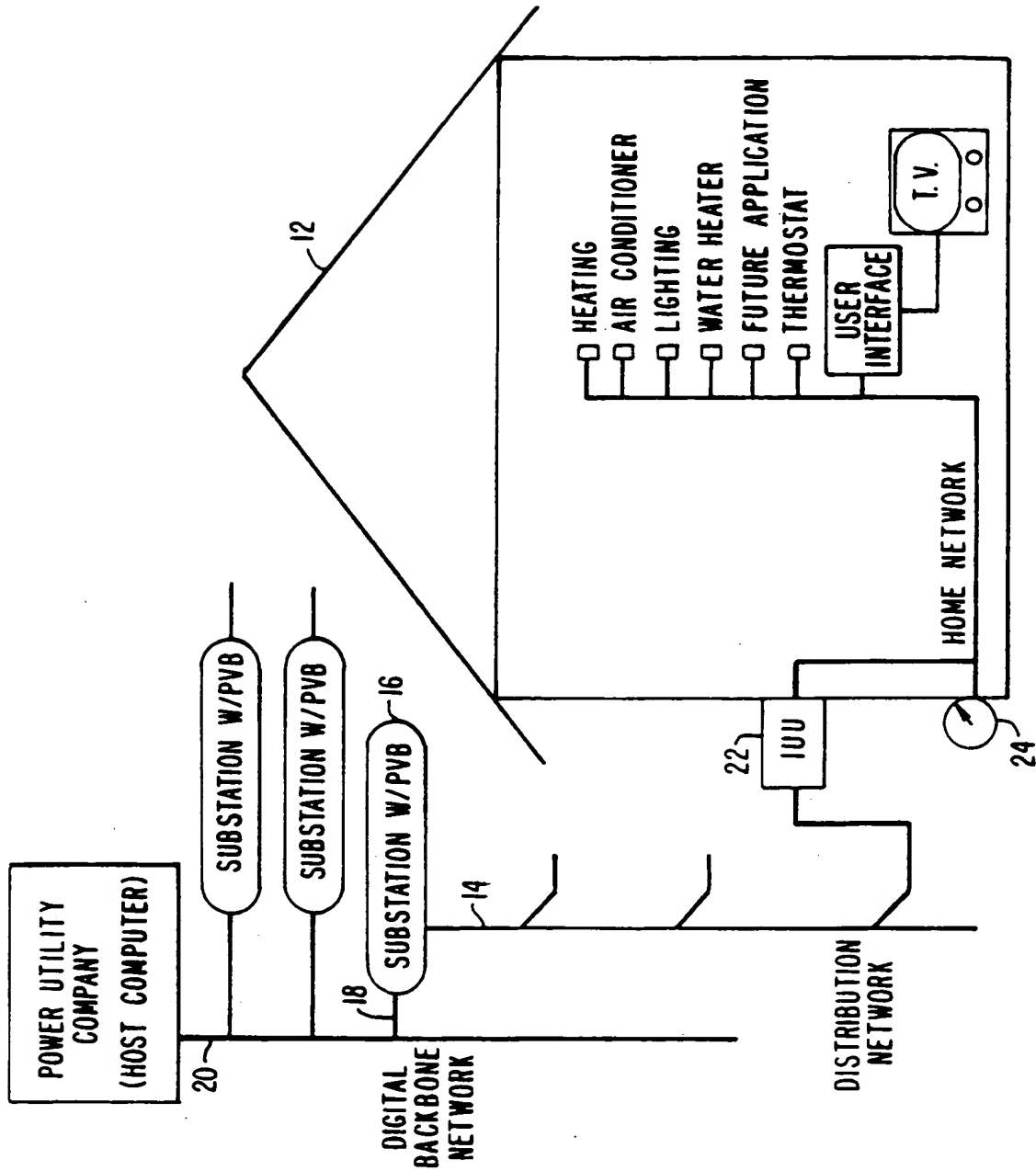


FIG. 2.

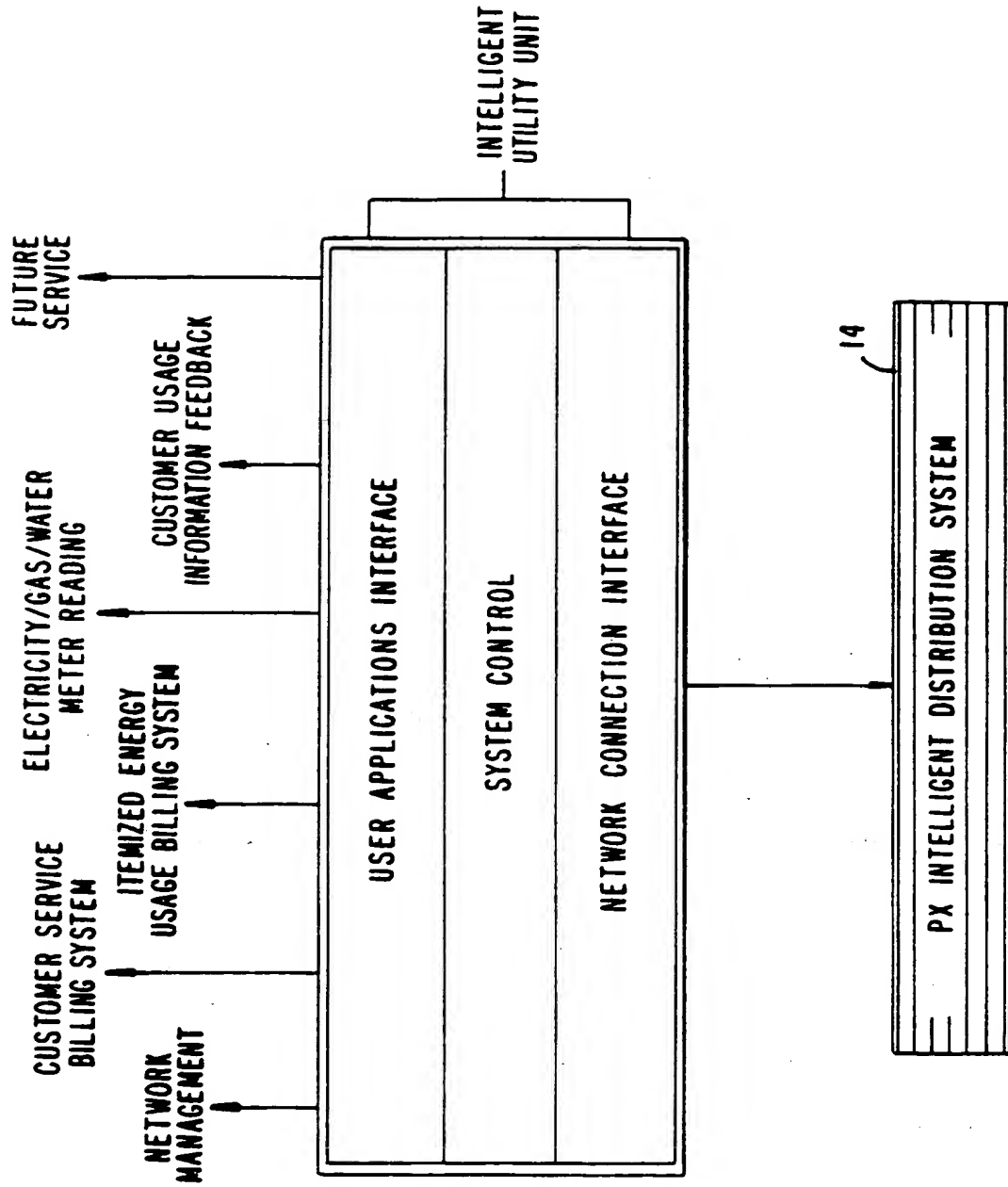


FIG. 3.

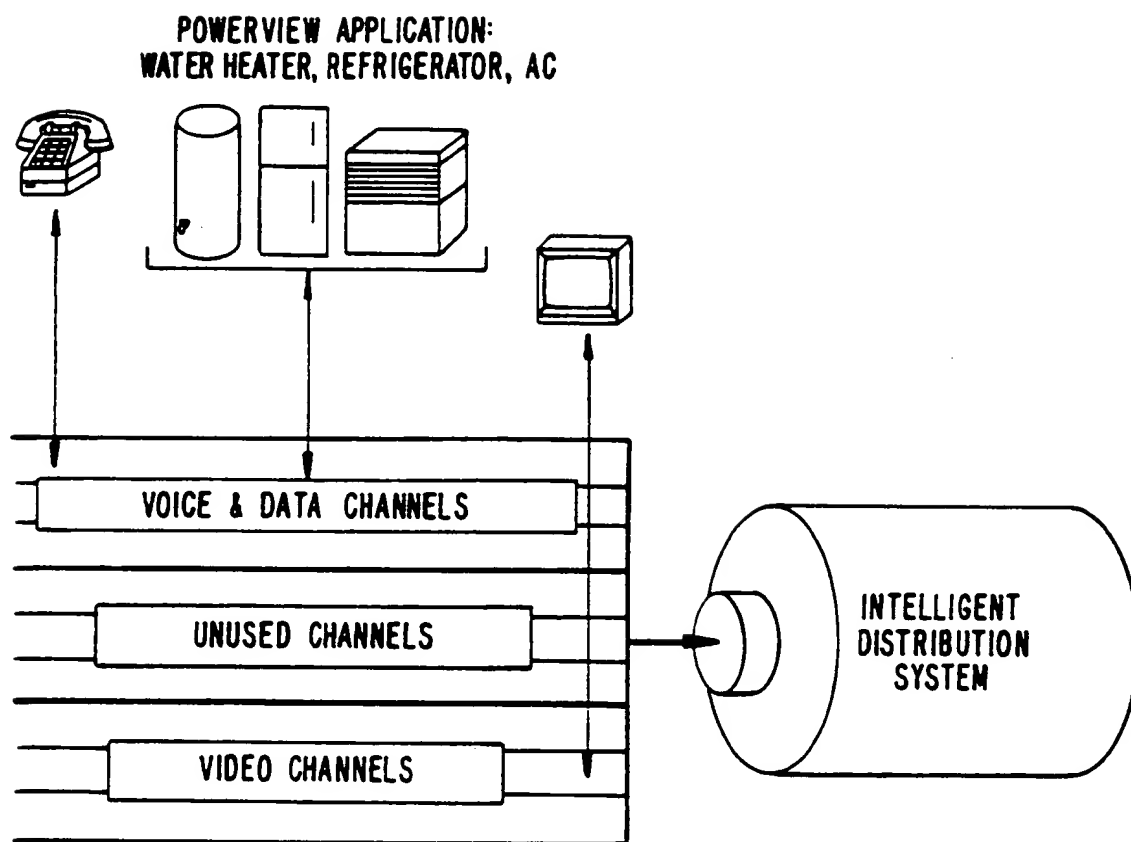


FIG. 4.

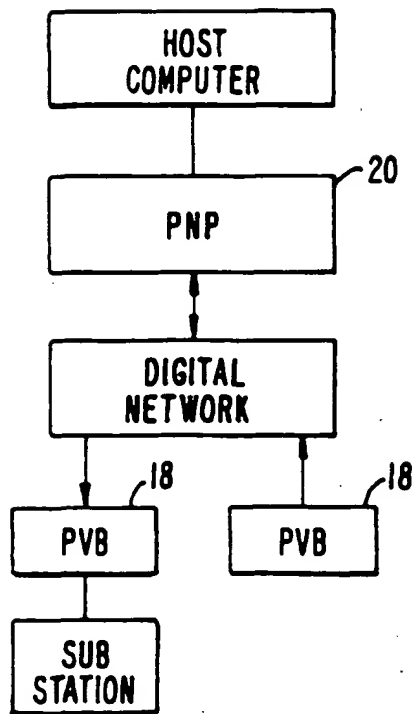


FIG. 5.

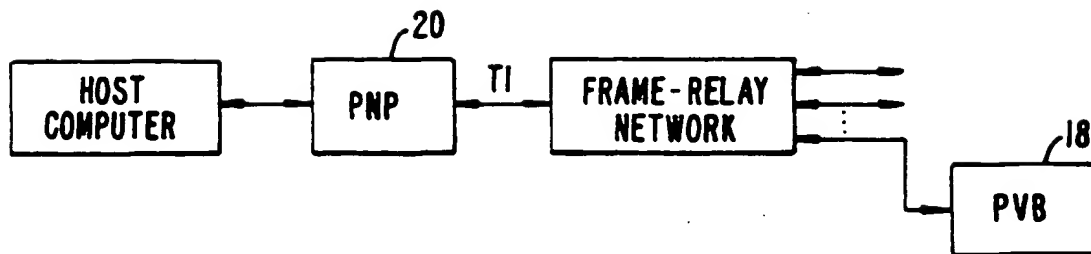


FIG. 6.



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EUROPEAN SEARCH REPORT

Application Number
EP 96 30 1661

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y A	EP-A-0 019 287 (TOCOM, INC.) * page 4, line 16 - page 10, line 20; figures 1-5 *	1,9 2-4,10, 11	H02J13/00
Y	EP-A-0 407 902 (ALCATEL) * column 2, line 31 - column 4, line 27; figure 1 *	1,9	
A	US-A-5 040 175 (TUCH ET AL) * column 2, line 56 - column 7, line 49; figures 1-7 *	1,2,9	
A	EP-A-0 503 464 (ALCATEL) * column 2, line 54 - column 8, line 21; figures 1,2 *	1,6,9	
A	EP-A-0 265 342 (SANGAMO WESTON) * column 4, line 50 - column 12, line 57; figures 1-4 *	1,9	
A	WO-A-95 12911 (UHER AG) * page 2, line 26 - page 3, line 35; figure 1 *	1,9	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	FR-A-2 677 469 (EURO CP) * page 3, line 12 - page 4, line 26; figures 1-3 *	1,9	H02J
A	ELEKTROTECHNIK UND INFORMATIONSTECHNIK, vol. 107, no. 7/8, 1990 - 1990, WIEN, pages 371-378, XP000150972 HACKL: "entwicklungstendenzen der modernen betriebsführungstechnik" * the whole document *		
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		18 June 1996	Calarasanu, P
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons</p> <p>& : member of the same patent family, corresponding document</p>			